Glass in Buildings: Design and Application
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Lecture - 02
Float Process for Manufacturing Glass

Hello everyone. Welcome to the module on Float Glass Manufacturing. In this module we will talk little bit about how the base glass is being manufactured through the process of float glass manufacturing.

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Before we go into that a bit little bit of brief about the glass history. Glass as everyone knows, it is not new, it is been there for ages; for nearly 6 millenniums. Glass was being manufactured for making jewelleries 4000 BC, long time ago. And over the years it has undergone various transformation and people have gone into blowing glasses making hollow glasses about 300 years ago making glasses flat for the first time by pouring it on a table. And the first continuous process in this process came into being in 1913 in the Fourcault and Colburn process. And from there the flat glass is transformed into a float glass manufacturing process in 1957 when this particular process was invented. And, as we speak till date this is the process which is seen as the best quality base glass producer for both architectural as well as for the automotive purposes.

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The float glass manufacturing process follows this sequence. First we need to have the raw materials, we prepare mix them and convert them into a batch and we take this batch with various raw material mixed up, it goes into the furnace where it is melted up to a temperature 1600 degree centigrade. And when the glass is molten it is cooled to a workable range, where we can give the thickness and the width to the glass. And then it takes its taken into the float bath and where the thickness and worth has been given and then, we take it into the annealing where the stresses are balanced and then we take it to the cutting to cut it into the shape and the sizes that the customer demands.

Glass is the way the glass is being manufactured couple of decades ago to how it is being manufactured. You can see little bit of data at the bottom the quantum of glass that is manufacturer worldwide and even in India we speak the quantity of glass is being produced is really in going up astronomically. This is one good thing that more and more of glass that we use the more natural materials that we are using for our architectural as well as various other applications.

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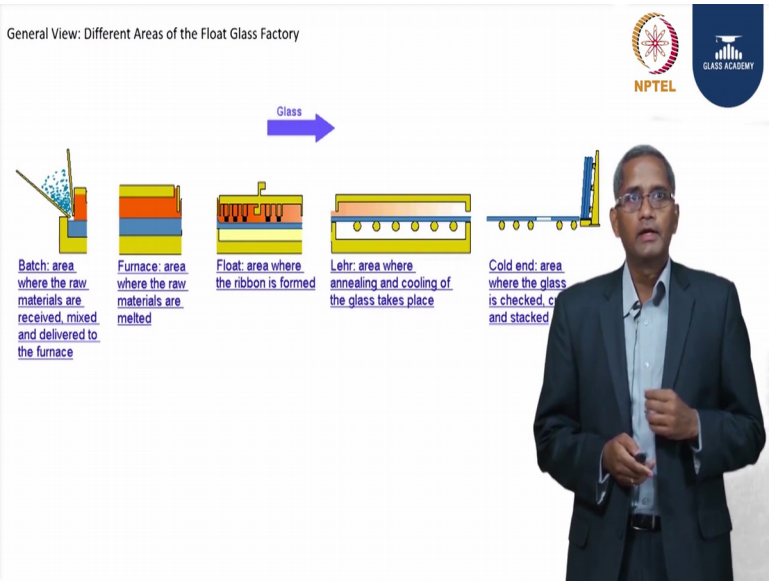

So, the batch area is where the raw materials are received; its mixed in the right proportion and delivered into the furnace. In the furnace area is where the raw metals are melted; as I said at a temperature of 1600 degree centigrade which mind you it is one-third the surface temperature of the sun. And from there it is taken into the float bath where there is a molten tin bath on top of which the glass is made and float on top of the molten tin. At that time we few equipments like the top roll machines to give it thickness and the width which we want to meet the customer demands.

Once the thickness and the width is given, then we need to cool the glass to room temperature. While doing so we need to be very cautious and careful, because the glass can undergo stress. So the annealing, the slow rate of cooling is done in the layer where the cooling is done in different stages before it reaches the cutting line at a temperature of 60 degree centigrade when the glass is cut to different dimensions and then its stacked and packed and dispatched to the customers place.

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Little bit about the raw materials. And I think most of you would know that to make glass we need silica sand. If you melt silica you will get glass, so the glass silica is called as the glass form. There are also few other raw materials that we are adding to the silica sand. We will see that need and they purpose began adding these raw materials in the next couple of slides.

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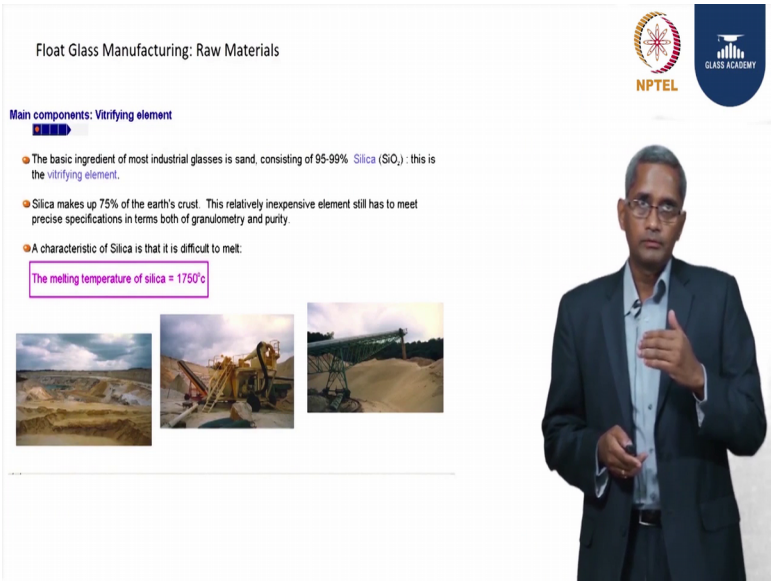

Now, as I said silica sand is the main raw material that is used to make glass. If you melt silica you get glass, but the problem is the silica melting point is very high at 1350

degree centigrade. To melt at such high temperatures we will be requiring lot of energy, and on top of that we need the furnace which can withstand such high temperatures. And to you know give you an another information nearly 75 percent of the earth crust is made up of silica and so most of the refractories that we manufacture that we use in the furnaces are also made up of silica.

How do we melt silica in silica furnaces? So, we need to have a very high temperature withstanding refractories which is going to make the furnace cost very very expensive.

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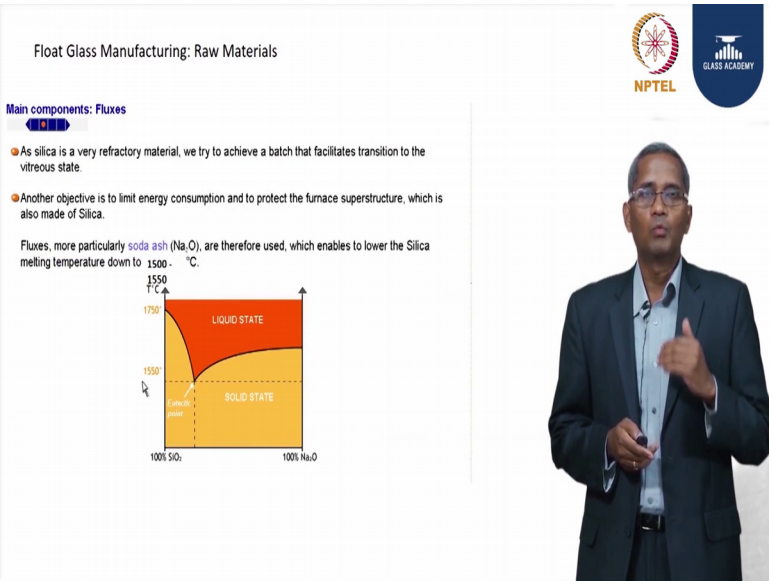

So, for the simple reason we need to bring down the temperature at which we can melt this silica sand, and for this purpose we add the flux. Flux in the form of soda ash, sodium carbonate is added at about 13.5 percent of the total composition of glass into the sand which will reduce the melting point; what was 1750 is down below 1600 degree centigrade.

So, we wanted to make glass. So, we melt we want to melt silica we have a temp problem of high melting point, so we added the flux in the form of soda ash now we were able to melt the silica into glass.

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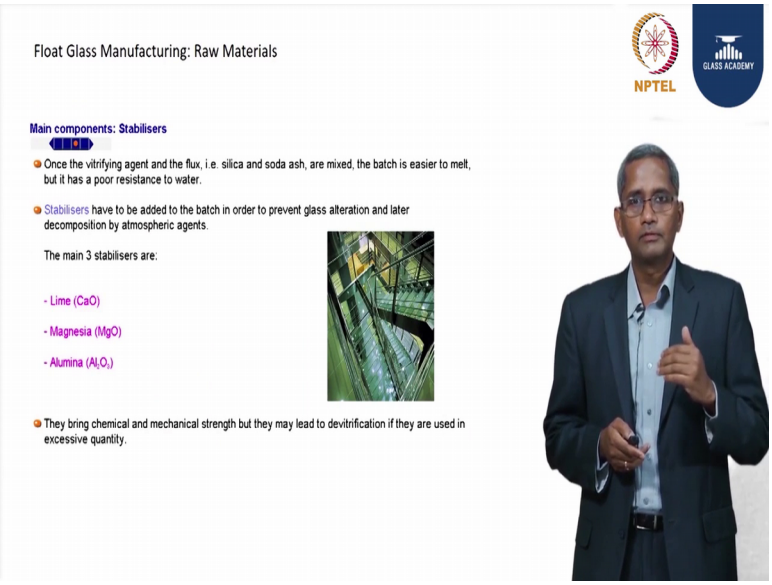

But the problem is the product that we get out of the mix of silica as well as the soda is not stable which means that it does not have the enough strength. Like our bones need calcium magnesium etcetera the glass also need a lot of strength and to give the strength we input calcium oxide, magnesium oxide, and alumina. And this will stabilize the glass and give it the required strength. The calcium oxide comes from both dolomite and limestone and the magnesium oxide comes from dolomite, and alumina if it is not adequately represented in the raw material main raw materials we can supplement with feldspar which has high alumina content.

So silica the glass former, to reduce the melting point of silica the flux we add soda and to stabilize the glass we add calcium oxide magnesium oxide and alumina. Now, what we want to make glasses? In the SiO 2 its available in the form of SiO 2 itself, the flux we need it in the form of Na2O, but what we add is in the form of Na2CO3. Na2O goes into the glass the CO 2 escapes into the atmosphere. As a stable I said what we need is CaO into the glass, but what we add is limestone and dolomite which is available as CaCO 3. The CaO goes into the glass and CO 2 escapes into the chimney.

And similarly MgO is required, Mg we supplement in the form of MgCO 3 through dolomite. So, MgO goes into the glass and CO 2 escapes into the atmosphere. So in fact, for every 100 kg of raw material that we add only 82.3 percentage of the material crest converted into the glass the remaining 17.7 percentage goes off as CO 2 into the

chimney. This process of removal of the CO 2 from the raw material is called as the process of refining. Once the raw metals are melted next the CO 2 has to go out and this refining has to may ensure that there is no CO 2, in the form of bubbles that is present in the glass is not there anymore.

In order to make this refining process much more efficient we add a refining agent that is in the form of sodium sulphate.

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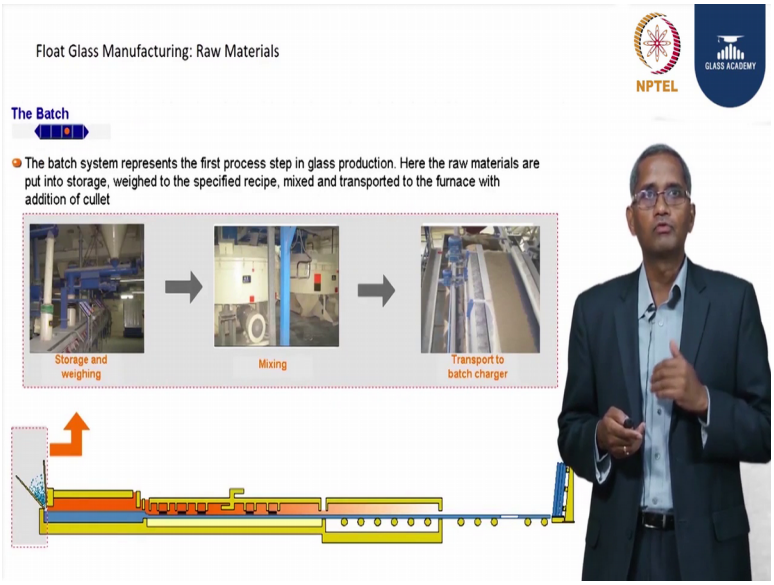

So, these are the basic raw materials that we use. To make different tinted glasses for example, in the form of green we need to add iron oxide, we have to make a blue glass we need to add iron oxide plus cobalt oxide. We in order to make a glass which is bronze intent we need to add selenium, in addition to iron oxide and then to make grey glass we need to add a nickel oxide. So, we add this small color and components to the main components which once again I repeat: the glass form a silica and the flux to reduce the melting point soda, in the form of soda ash and to give the stability the strength required to the glass CaCO 3 MgCO 3 and alumina we had it in the form of limestone dolomite and fill spa. And then to get this refining process done efficiently we add the refining agent which is sodium sulphate.

All these raw materials in the right proportion are mixed in what is known as a batch plant. There are big silos which stores is material and from there it is taken weighed down and then from there it is taken to a mixer. A bit of water is added to ensure that the

batch is that a good 3.5 to 4 percentage moisture content which will keep the different raw materials homogenous. The homogeneity of the raw metals is very very important. To make sure that the glass is optically good in quality the chemical homogeneity is the most important things. So, the quality of the glass is largely determined by how good raw material that we put into the furnace and how well we homogeneously mix it. So, batch plant is very very crucial to make sure that the final glass quality is the best level that we can aim for. So, from the mixer it goes into the furnace through what we call as the doghouse.

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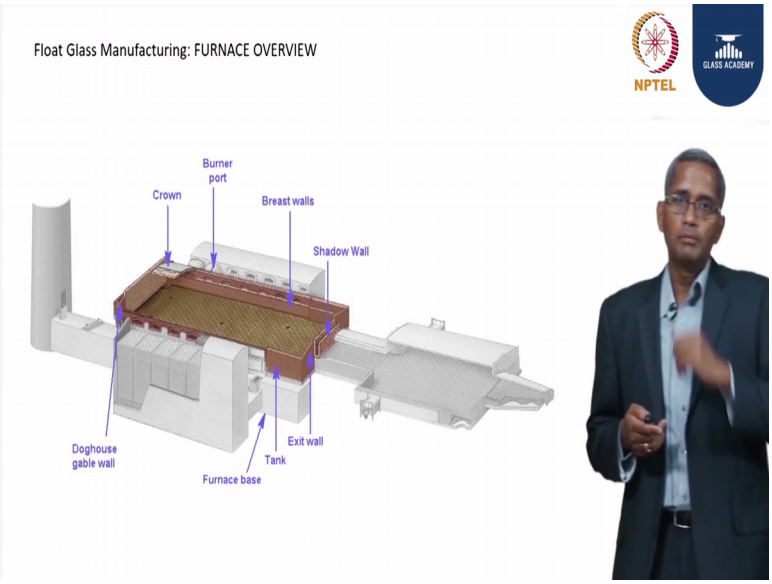

So, these are all this is the schematic which shows a different parts of the furnace, and where the raw material enters into the furnace is called as the doghouse. Typically the doghouse is something which is there at the entrance of a house and so this is a place where you feed the raw material, so it is called as a doghouse. And the furnace in itself has got 3 components to it: the first is the melter which is a melting and refining taking place, after that is what we call as the neck, and the third segment is called as a working end. And each of the segment has got 3 parts vertically if we have to take it: one is the tank which holds the molten glass, and of course we need a roof around which is called as a crown, and this space between the tank and the crown is called as a superstructure.

And we have on both sides as you can see on the sides what is called as a regenerator. There is a lot of heat that we need to provide into the furnace to ensure the glass is

melted. And so in order to retain the furnace at such high temperatures we need to necessarily let the flue gas go out at a high temperature. In order to regenerate this waste gas at a high temperature going out of the furnace we have regenerators which puts back the heat back into the system.

So the first is the melter, where the melting happens and the refining happens and then it goes into the neck. As you can see then the neck has got a very narrow channel in which having melted and refined the glass; now we need to thermally homogeneous you know bring the glass together and also provide few equipments in the neck mixing equipments so that we mix the glass together thereby the temperature of the glasses more or less homogeneous which also is essential for the optical quality of glass

So, having melted refined and homogeneously bringing the glass together, now we need to bring the temperature of the glass to the workable range. So, the end in which we bring the glass to workable range is called as a working end. And then we take the glass into the forming region which is a float bath at 110 degree centigrade.

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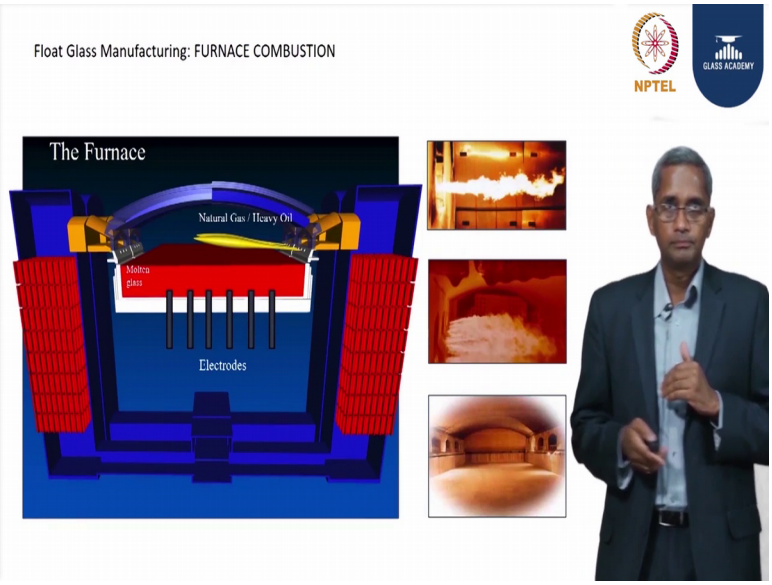

So, some more details of the furnace: you can see this is how the cross section of the furnace would look like. There are obviously, in order to provide 1600 degrees temperature that we maintain the furnace with we need a lot of fuel, a most of the furnaces would use natural gas and for the plants which do not have the facility for natural gas also uses heavy oil. So, there is a furnace setup on both the sides as you can

see in this diagram. In addition to the heavy oil or the gas we can also supplement energy in the through electrodes from the bottom.

So, this is quite efficient the electrodes, if we make tinted glass for example, because the bottom temperature tends to go too low because of the heat transfer being restricted due to the non availability of radiation as a source of heat transfer. The electrodes from the bottom can really help in quickly providing the heat into the molten glass from the bottom.

We will come to that later. For now this particular pictures shows us how the fuel is being injected in this case we call it as a right side as in the picture we can see and the flame is coming out from the right side. The oxygen that is required for this combustion comes through the regenerator. The red color the blocks that you see on both sides, the oxygen the form of combustion air comes through the regenerator on the right side, and comes over where the oil is being injected into the furnace the combustion takes place. The ignition temperature is already available because the furnace is always maintained at 1600 degree centigrade.

So, from the right hand side firing with the heat going into the glass the waste gas goes out of the furnace through the left hand side regenerators, when it goes out the temperature of the flue gas is around 1450 degree centigrade. In order to maintain this temperature at 1600 inside the furnace there is no other way but to let the flue gas go out at 1450 degree centigrade. This flue gas when it goes out through the regenerators on the left hand side the regenerator is stacked up with special refractories which can quickly absorb the heat; quick heat transfer capacity and also got a very high area surface area to volume ratio. So, that it has a lot of surface area for it to take the heat of the flue gas that is going out.

So, when the flue gas comes out this refractory is absorb the heat, and what comes in the waste gas at 1450 degree centigrade when it goes out into the chimney related at 450 degree centigrade. These regenerators continue to absorb the heat, but it has been designed in such a way that it can absorb the heat for about 20 minutes time, not more.

So, what we do is to do a process called as a reversal.

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